International Journal of Metallurgical & Materials Science and Engineering (IJMMSE)
ISSN (P): 2278-2516; ISSN (E): 2278-2524
Vol. 8, Issue 4, Oct 2018, 1-4

FACTORS AFFECTING THE FORMATION OF GAS POROSITY IN A356 ALLOY WHEEL BY GRAVITY DIE CASTING

ATUL N. MESHRAM[1], D. N. RAUT[2] & S. K. MAHAJAN[3]

[1]*Research Scholar, Department of Production Engineering, Veermata Jijabai Technological Institute, Matunga, Mumbai, India*

[2]*Professor, Department of Production Engineering, Veermata Jijabai Technological Institute, Matunga, Mumbai, India*

[3]*Director of Technical Education, Government of Maharashtra, India*

ABSTRACT

The majority of the defects occur in the in Aluminium alloy casting are due to mold parameters, filling and during solidification. Aluminium alloys form oxide layer on top of the molten metal in holding furnace immediately when it comes in contact with the atmosphere forming oxide on its surface. This oxide layer forms bifilms due to turbulence. This leads the gas to get entrapped in the molten metal causing gas porosity in the casting. The gas entrapped in the casting during filling causes gas porosities during solidification. The study focused on identifying & controlling the parameters affecting formation of gas entrapment while casting A356 alloy wheel using GDC results into formation of gas porosity. Effect of various parameters like, pouring temperature, degassing time and Volume in holding furnace on the formation of porosity was checked for wheel samples and Reduced Pressure Test (RPT) samples.

KEYWORDS: Bifilm, RPT & GDC

Received: Aug 18, 2018; **Accepted:** Sep 08, 2018; **Published:** Sep 21, 2018; **Paper Id.:** IJMMSEOCT20181

Original Article

INTRODUCTION

As the liquid aluminium is highly reactive with oxygen, oxide film is formed in the mould within no time in case of aluminium casting. The oxide films are often responsible for the failure of castings. The turbulence causes entrained films to get furled during the filling. It is thought that a furled, thin bifilm may be unfurled by the four main factors of hydrogen precipitation, dendrite pushing, shrinkage and inclusion. The unfurling phenomenon is important because it can affect and reduce the mechanical properties. Gravity die casting (GDC) has been one of the most economical and simplest ways of casting metals and alloys. The folding of the advancing front of the liquid metal causes many problems such as entrained air, bubbles and oxide bifilms.

LITERATURE REVIEW

R. Raiszadeh and W D Griffiths (2006), suggested that the atmosphere within a double oxide film defect should be consumed by the surrounding Al melt in less than two minutes. D. Dispinar and J. Campbell (2004) and Derya Dispinar (2005), confirmed that the bifilms are the initiator and hydrogen is only a contributor to the porosity formation process. D. Dispinar and J. Campbell (2004), explained the purpose of study of reduced pressure test. W. D. Griffiths, A. O. Omotunde and R. Raiszadeh (2006) researched to understand the change in the

behaviour of the double oxide film defects once they are formed, and their development with time.

EXPERIMENTAL SETUP

The experimental work is performed in an alloy wheel industry manufacturing Alloy wheels of A356. Fresh ingots and chip, rejected wheels, rings and sprues are used for melting in the gas fired furnace for around 1 hour so that the temperature of the melt reaches 750^0C-780^0C. Degassing was done with Nitrogen gas. Melt is then held for some time before it is poured into the die of gravity die casting machine to make alloy wheels. Here along with the alloy wheels and Reduced Pressure Test (RPT) samples were taken with the same set of parameters using Taguchi's DoE for maximizing the response.

Table 1: Experimental Design (L9)

TC	Pouring Temperature, PoT (°C)	Degassing Time, DgT, (Minutes)	Volume in Holding Furnace, VoH, (Full, Medium, End)
1	710	10	F
2	710	15	M
3	710	20	E
4	725	10	M
5	725	15	E
6	725	20	F
7	740	10	E
8	740	15	F
9	740	20	M

Table 2: Factors and its Levels

Factors	Level 1	Level 2	Level 3
Pouring Temperature, PoT (^{0}C)	710^0C	725^0C	740^0C
Degassing Time, DgT (Minutes)	10 Minutes	10 Minutes	10 Minutes
Volume in Holding Furnace, VoH (kg)	500 kg (Full)	250 kg (Medium)	100 kg (End)

Experiments were performed and for each treatment condition (TC) alloy wheels of A356 were taken using Gravity Die Casting machine. The wheels were then Heat Treated (T6).

Reduced Pressure Test (RPT) was performed and the density was obtained which was the measure to find porosity. The molten aluminium sample is kept inside the specially designed SS chamber with the vacuum in a glass dome. The molten sample is kept under vacuum for about 5 minutes, and residual gas in the sample is indicated on the upper surface of the sample as well as very prominently indicated as gas porosities when the sample is cut/ machined. The size & the number of porosities depend on the gas content of the sample. The parameters kept same for wheel and RPT samples

RESULTS AND DISCUSSIONS

Totally 9 Experiments were performed and for each treatment condition (TC) and alloy wheels of A356 were taken using Gravity Die Casting machine. The wheels were then Heat Treated (T6). Reduced Pressure Test (RPT) was performed and cut sections and wheel sections microstructures showed porosity in the samples. The factors contributing to it were pouring temperature, degassing time and Volume in holding furnace.

The structure consisted of a network of Si particles in the inter-dendritic Al-Si eutectic. Three samples are shown here with porosities.

Samples taken by reducing pressure tests were cut, which showed porosities in the cut sections. The wheel sample and the reduced pressure test samples are taken from the same sets of parameters. The density obtained from RPT samples was the measure to find porosity. More porosity means lesser is the density.

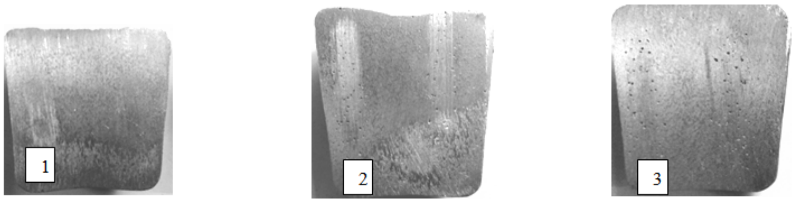

Figure 1: Cut Sections of RPT Samples

Table 3: Density of RPT Samples

RPT Sample	1	2	3
Density (gm/cm^3)	2.64	2.53	2.47

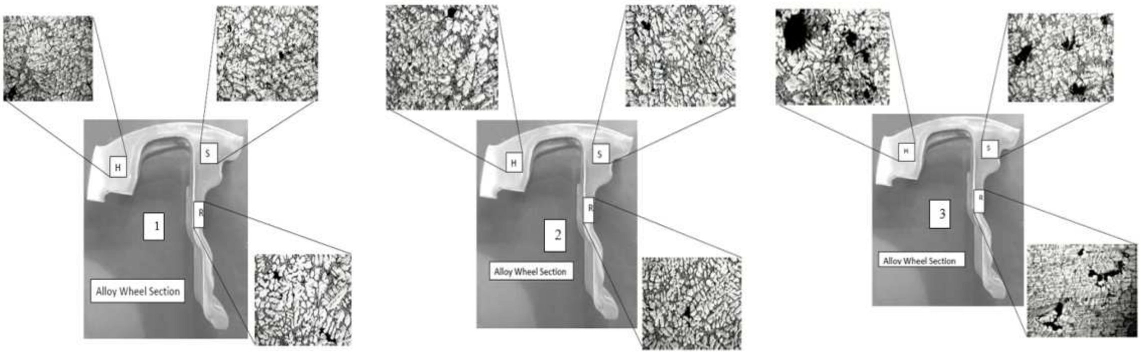

Figure 2: Results of Micro Examination Wheel 1, 2 and 3

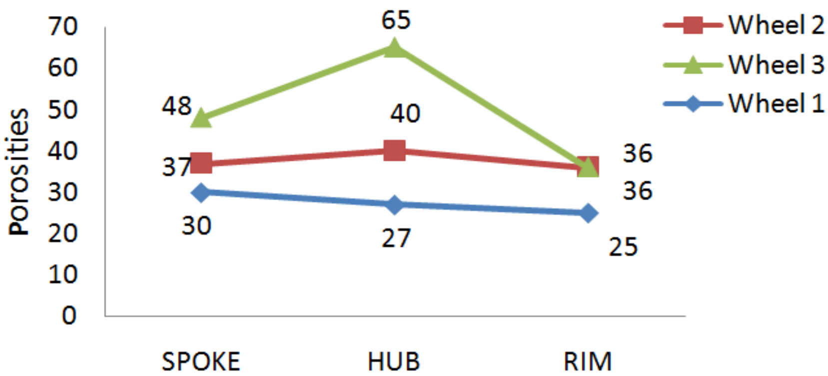

Figure 3: Porosities in Wheel Section

CONCLUSIONS

The microstructure shows porosities in the Hub, Spokes and Rim. Lesser porosity is seen in the samples taken with less temperature and when the furnace is full. The porosity increases when pouring temperature increases and when the level in the holding furnace goes down. Degassing is done for longer period, gives cleaner metal for pouring. The turbulence in molten metal before pouring forms bifilms which gets entrapped causing porosities in casting.

ACKNOWLEDGEMENTS

Authors are thankful to NEO Wheels Limited, Rabale MIDC, Thane, for their continuous support in performing experiments and tests in the industry.

REFERENCES

1. *Campbell, John. Castings. Butterworth-Heinemann, 2003.*
2. *Dispinar, Derya. Determination of metal quality of aluminium and its alloys. Diss. University of Birmingham, 2006.*
3. *Dispinar, D., et al. "Degassing, hydrogen and porosity phenomena in A356." Materials Science and Engineering: A 527.16 (2010): 3719-3725.*
4. *Mirzaei, Behzad. "Oxide Hydrogen Interaction and Porosity Development in Al-Si Foundry Alloys." (2011).*
5. *Raiszadeh, R., and W. D. Griffiths. "'Study of double oxide film defect behaviour in a quiescent aluminium melt'." Foundry Trade Journal 180.3639 (2006): 296.*
6. *Dispinar, D., and J. Campbell. "Critical assessment of reduced pressure test. Part 1: Porosity phenomena." International Journal of Cast Metals Research 17.5 (2004): 280-286.*
7. *Dispinar, D., and J. Campbell. "Critical assessment of reduced pressure test. Part 2: Quantification." International Journal of Cast Metals Research 17.5 (2004): 287-294.*
8. *John Campbell. 10 Rules for Good Castings. Modern Casting, April 1997*
9. *John Campbell and Richard A. Harding. TALAT Lecture 3207, Solidification Defects in Castings. IRC in Materials, The University of Birmingham*
10. *Monroe, R. Porosity in castings. AFS Transactions 113 (2005): 519-546.*
11. *Campbell, John. "Sixty Years of Casting Research." Metallurgical and Materials Transactions A 46.11 (2015): 4848-4853.*
12. *Campbell, J. "Entrainment defects." Materials science and technology 22.2 (2006): 127-145.*
13. *Samuel, A. M., Alkahtani, S. A., Doty, H. W., & Samuel, F. H. (2016). Porosity formation in Al–Si–Cu alloys. Int. J. Metall. Mater. Sci. Eng, 6, 1-14.*